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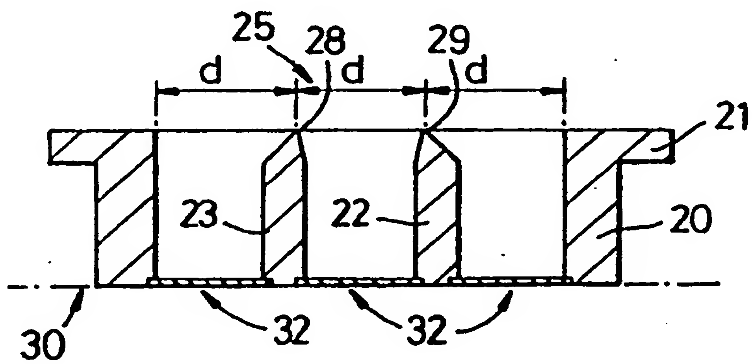
(57) Abstract

A spinnerette for the spinning of fibres comprising a rectangular frame (20) having an upper flange (21) for connection to a jet assembly and a lower planar apertured plate (32) for the passage of spinning dope, the apertured plate (32) being formed with its spinning holes and then electron beam welded into the bottom of the frame (20) from the outside.



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Spinnerette

This invention relates to spinnerettes and has particular reference to spinnerettes suitable for the spinning of shaped cellulose products (e.g. filaments) from a solution of cellulose in a solvent, particularly a tertiary amine N-oxide.

McCorsley US Patent 4,416,698, the contents of which are incorporated herein by way of reference, describes a system of producing cellulose filaments by dissolving the cellulose in a suitable solvent such as a tertiary amine N-oxide. One of the features of such a system is that the solution, commonly referred to as a dope, is both hot and, if it contains a significant quantity of cellulose, viscous, requiring the use of extrusion pressures in the range 15 bar to 200 bar. Such pressures are similar to those experienced in melt-spun polymer systems, such as polyester systems.

Having produced the solution of cellulose in the solvent the solution is extruded or spun through a suitable die assembly including an unspecified jet to produce shaped material which is passed into water to regenerate the cellulose by leaching out the amine oxide solvent from the extruded material.

The production of artificially formed filaments of material by extruding or spinning a solution or liquid through a spinnerette to form the filaments is, of course, well known. Initially, relatively small numbers of individual filaments were prepared, which filaments were individually wound up for use as continuous filament material. This meant that the number of continuous filaments which needed to be produced was essentially dictated by the number of filaments which could be individually wound either before or after drying.

However, if fibre is produced as a tow or if fibre is produced as staple fibre then different criteria apply to the number of filaments which can be produced at any one time.

A tow essentially comprises a bundle of essentially parallel filaments which are not handled individually. Staple fibre essentially comprises a mass of short strands of fibre. Staple fibre can be produced by the cutting of dry tow or it can be produced by forming a tow, cutting it whilst still wet, and drying the cut mass of staple fibre.

Because there is no need to handle individual filaments in the case of a tow product or a staple product, a very large number of strands or filaments can be produced simultaneously.

Thus in the case of spinnerettes for the production of tow or staple fibre, in comparison to spinnerettes used for the production of continuous filament material, it is economically essentially to use spinnerettes with a large number of spinning holes.

Initially, a spinnerette for the production of continuous filament might have had 20 to 100 holes, with productivity being increased by the use of higher spinning speeds. With spinnerettes used for the production of tow or staple the numbers of holes can grow into thousands or even tens of thousands. Productivity can thus be increased by the use of more holes as well as higher speeds. Initially such spinnerettes with large numbers of holes were produced in thick plates, as in polyester jets. However, it is expensive and time-consuming to produce large numbers of holes in such thick plates. Thus attempts were made to use thinner plates by taking a dish of metal and forming the holes through the dish to produce a spinnerette in the form of a dished member with the holes arrayed in some suitable pattern in the lower portion of the dish. Such a dish member was then bolted into a jet for the production of the spun material.

Unfortunately, however, the production of jets is a very expensive and time-consuming process. Each hole has to be pierced individually. Very often the holes are of a complex shape and are produced by a series of drilling, punching or

machining operations, which have only recently been semi-automated.

With any production process there is a risk of defects and for a given percentage defect level, however low, the absolute number of defects per jet will increase as the number of holes in the jet increases. This can mean that there reaches a stage where it is not practical to increase the number of holes in a single jet face because of the chances that the final product will have too many defects to be useful without subsequent refurbishment.

One way round this problem is the adoption of the so-called cluster jet or thimble jet. In a cluster jet a large number of small thimbles are produced each with a specific number of holes - say 1 to 1500 holes. Such cluster jets have been widely used in the production of cellulose filaments by the viscose process. The individual thimbles of a cluster jet can be manufactured relatively cheaply and if a defect is found in one hole in one thimble that particular thimble can be replaced without losing the work of producing many thousands of holes. The thimbles of a cluster jet are inserted into a holder in such a way that the pressure of the dope or spinning solution acting within the spinnerette tends to firmly force the spinnerettes into the cluster jet holder assembly.

Such jet assemblies of the single dished jet type with a large number of holes or a cluster jet type are widely used in the production of viscose cellulose. Viscose cellulose is produced by wet spinning. Examples of such jets are to be found in Ullman Encyclopaedia of Industrial Chemistry, 5th Edition, 1987, volume A10, page 554.

Ullman also refers to the use of rectangular spinnerettes in the spinning of polyolefin fibres.

The present invention is concerned with the production

and structure of a spinnerette particularly suited for the production of cellulose fibres from a solution of cellulose in a solvent. Such spinnerettes are further particularly useful for the production of staple fibre of cellulose from a solution of cellulose in a solvent such as amine oxide.

In one aspect of the present invention there is provided a spinnerette which is characterised in that it comprises a metal aperture plate, the plate having a plurality of holes for the spinning of a shaped product from a spinning solution, the aperture plate being welded around its periphery to a metal frame member.

In a further aspect a spinnerette for the spinning of a plurality of cellulose filaments from a solution of cellulose in a solvent, the spinnerette having a frame member defining a portion through holes of which the solution is passed to form the filaments, is characterised in that the holes closest to the frame member are larger in diameter at their smallest diameter portion than the holes in a region more remote from the frame member.

In a still further aspect of the invention a spinnerette for the production of a plurality of cellulose filaments from a solution of cellulose in a solvent for the cellulose, is characterised by:

i) a metal framework including an outer wall of generally rectangular shape in plan view, the outer wall defining a space of depth between the two edges of the wall equal to the depth of the spinnerette, the rectangular framework having a length and a width, wherein the length is greater than the width so as to define a major axis and a minor axis,

ii) an outwardly extending flange around the periphery of the wall integral with the wall,

iii) at least one major axis internal bracing wall and at least one minor axis internal bracing wall transverse to the major axis bracing wall provided within the outer wall thereby defining a plurality of apertures through the framework,

iv) rebates in the portions of the outer wall and the portions of the braces at the outer edges thereof around the periphery of each aperture to accommodate in each aperture an aperture plate,

v) a plurality of metal aperture plates dimensioned to fit into the rebates around the apertures,

vi) a plurality of spinning holes formed in each of the aperture plates through which the cellulose solution can pass to form the filaments, and

vii) the aperture plates being welded in the rebates to the framework and braces around the entire periphery of each aperture plate.

The present invention further provides a method of manufacturing a spinnerette for the production of a plurality of cellulose filaments from a solution of cellulose (preferably in a tertiary amine oxide), which method is characterised by:

(i) providing a stainless steel framework including an outer wall of a generally rectangular shape in plan view, the outer wall defining a space of a depth between the two edges of the wall equal to the depth of the spinnerette, the rectangular framework having a length and a width, wherein said length is greater than said width so as to define a major axis and a minor axis,

(ii) at one peripheral edge of the wall providing an

outwardly extending flange around the periphery of the wall integral with the wall,

(iii) providing within the outer wall at least one major axis internal bracing wall and at least one minor internal axis bracing wall transverse to the major axis bracing wall defining a plurality of apertures through the framework,

(iv) forming rebates in the portions of the outer wall and the portions of the braces at the outer edges thereof around the periphery of each aperture to accommodate in each aperture an aperture plate,

(v) forming each of the braces with a tapered upper edge remote from the rebated edge.

(vi) forming a plurality of aperture plates from stainless steel dimensioned to fit into the rebates around the apertures,

(vii) forming a plurality of spinning holes in each of said aperture plates through which the cellulose solution can pass to form the filaments, the holes being tapered so as to be larger in diameter on one side of said aperture plate than on the other side,

(viii) subsequent to the formation of the spinning holes in each of the aperture plates, locating the aperture plates in the rebates in the apertures with the side of the aperture plate having the larger diameter portion of the holes towards the bottom of the rebate, and

(ix) electron beam welding the aperture plates to the framework and braces around the entire periphery of each aperture plate.

The invention will now be further described, by way of example, with reference to the accompanying drawings, in which:-

Figures 1A, 1B and 2A, 2B illustrate prior art spinnerette designs of the simple dish type and of the cluster jet type,

Figure 3 is a perspective view of a spinnerette in accordance with the invention,

Figure 4 is a plan view of Figure 3,

Figure 5 is a sectional view of Figure 3,

Figure 6 is an enlarged view of a corner of Figure 5,

Figure 7 is a further enlarged view of Figure 6,

Figure 8 is a perspective view of an aperture plate,

Figures 9A to 9G are plan views of portions of aperture plates,

Figure 10 is a sectional view of a hole, and

Figure 11 is a plan view of a spinnerette.

Referring to Figures 1A and 1B these show a prior art spinnerette (seen in sectional view in Figure 1A) in the form of a dished plate 1 (seen in end-on view in Figure 1B) having an integral flange portion 2. The flange 2 is trapped between a large nut 3 screwed onto the back of a jet head 4. In turn the jet head is connected, via any suitable coupling member 5, to a pipe 6 for the supply of spinning solution, commonly referred to as a dope. Such a prior art device essentially has a plurality of holes 7 formed in the base 8 of the dish to produce from the dope the filaments which form the fibre.

In the case of such a spinnerette used in the production of viscose rayon, the spinnerette would be immersed in a spin bath to regenerate cellulose fibres from the dope as it passes into the spin bath. For the production of continuous filament viscose, the number of holes 7 would be in the range of about 10 to 100.

For the production of tow (a plurality of essentially parallel filaments used as such) or staple fibre (small lengths of individual fibres produced by cutting up a tow) the number of holes 7 can be increased to a very high level indeed. The prior art devices of this type may typically be formed as large as 10 cm in diameter and may have as many as 50,000 holes. The holes may be arrayed in patterns, such as segments, as is, for example, illustrated in Ullman 5th Edition 1987, volume A10, page 554.

For the reasons outlined above, increasing the number of holes in the spinnerette can cause practical manufacturing problems which are associated with the virtual impossibility of reducing the statistical defect rate to zero. One answer to this problem is the use of a cluster jet of the type illustrated in Figures 2A, 2B. The portion of the cluster jet illustrated in Figure 2A effectively replaces the dished plate 1 and nut 3 and is screwed by an internal thread onto the backing member 4 illustrated in Figure 1A. In the embodiment illustrated in Figures 2A and 2B the cluster jet comprises a substantial metal dished member 9 having the internal thread 10 referred to above and being formed with a series of stepped bores 11. These bores have a larger diameter 12 on the inside and a smaller diameter 13 on the outside. Located within the stepped bores 11 are a series of thimbles such as thimble 14 which in turn has an integral flange 15 an annular wall 16 and a base 17. The spinning holes 18 are formed in the base 17. In such prior art devices the thimbles are inserted from the inside of the substantial holder so that the action of the pressure of the dope on the thimbles is to force the dope into strong contact with the thimbles 12 so as to urge the thimbles

into contact with the tapered portion 13 of the holes. The purpose of inserting the thimbles from the inside is to enhance sealing of the thimbles in the holes by having the pressurised dope act in a direction to enhance sealing. If required, each thimble may be screwed into the hole or may be retained in the hole by providing in the portion 12 of the hole a female thread and threading a tubular male member (not shown) into the threaded bore portion 12 of the hole 11. The thimbles 14 may project beyond the face 18 of the member 9. This can clearly be seen in the Ullman Encyclopaedia article referred to above page 554, volume A10, 1987.

Referring to Figures 3 to 8 these show a spinnerette in accordance with the present invention. The spinnerette is essentially of rectangular shape as shown in Figure 3. The spinnerette is of generally top hat shape having a rectangular outer wall 20 with an integral upper flange member 21. The flange member may be provided with holes. Located within the wall 20 and integral with or welded thereto are a series of bracing walls 22, 23, 24. The braced structure may, in the case of an integral unit, be machined from a single plate or thin slab. The bracing walls 22 and 23 are formed along the major axis of the spinnerette and the bracing wall 24 lies transverse to the major axis along a minor axis of the spinnerette. The bracing walls form, together with the outer wall 20, a series of apertures or windows such as aperture 25. The material from which the outer wall and braces of the spinnerette is formed is preferably stainless steel and is further preferably stainless steel in accordance with AISI code 304. The upper walls of the braces 22, 23 and 24 are tapered to form substantially knife edge lines such as lines 27, 28, 29. The knife edge 27 of the brace 24 is centrally located on the brace, but the knife edges 28, 29 of the braces 22 and 23 (see Figure 5) are located to one side of the brace members, so that the distances d are all equal, and hence, as the apertures are all the same length, the areas of the apertures are all the same. This means that, in use, substantially equal amounts of dope are passed into each

aperture. The use of tapered braces reduces the pressure drop of the dope across the jet compared to flat topped braces.

At their lower ends, the peripheral outer wall 20 and the bracing walls 22, 23, 24 define the lower edges of the apertures. The bottom of each of the bracing walls lies in the same plane 30 as the base of the outer wall 20. Around each aperture the walls are rebated such as at 31 to accept an aperture plate 32. The aperture plate 32 is also formed of stainless steel, in this case AISI code 430 stainless steel. Formed in the aperture plate 32 are a series of spinnerette holes produced by conventional processing techniques such as those described in "Fiber Producer" December 1978 pages 42 to 50 by Schwab of Enka, or in "Fiber Producer" April 1978 pages 14 to 18 and 74 to 75 by Langley of Spinning Services and Systems, the contents of both articles being incorporated herein by way of reference. The spinnerette holes are preferably tapered in form as shown in Figure 7 so as to have a larger internal diameter on the inside of the jet and a narrower diameter on the outside of the jet. The plates, having been produced, are then located in the rebate 31 in the framework and braces of the spinnerette, and are electron beam welded around the periphery as at 33 to seal the plates within the apertures.

By selecting the plates 32 to be the same thickness as the depth of the rebate 31, and by the use of electron beam welding the underside of the spinnerette has a smooth face and effectively lies in the single plane 30.

Because the aperture plates 32 can be punched prior to assembly into the jet, and because they are substantially rectangular in form and flat they are easily handled and punched. There is no need to punch holes into a dished flanged member as was necessary with prior art designs. This means that the holes can be punched right across the plate very close to the edges. This in turn means that the spinning holes can come very close to the outer walls of the plate and

very close to the bracing walls. The use of electron beam welding minimises distortion of the assembly. By using the two particular grades of stainless steel referred to above, the softer grade used for the aperture plates can be punched to produce the shaped spinning holes whilst still being capable of being welded to the material of the frame. Electron beam welding is preferred as being a method of obtaining a high integrity joint without distorting the plates more than is necessary. Alternative methods of welding could include laser welding or plasma arc welding.

It can be seen, therefore, that the spinnerette has a smooth underside and may readily be manufactured from small components in terms of aperture plates whilst providing a large area for the production of large numbers of individual fibre strands.

The metal plates 32 preferably have a thickness in the range 0.5 to 3 mm. The use of the welded construction enables the plates to withstand the high internal pressures to which they are subjected in use. This means that the plates can be as thin as 0.5 mm whilst still enabling high pressure dope to be used in the production process. Alternatively, thicker plates may be provided such as plates as thick as 0.75 mm or 1 mm or 1.25 mm or 1.5 mm or 2 mm or 2.5 mm or 3 mm. The plates may be of almost any length along the major axis, as the plates are supported by being welded on either side on the minor axis. Typically the width of the plate may be about 50 mm but it may be 10, 15, 20, 25, 30, 35 or 45 mm wide. The plates may be up to 500 mm long or even longer and typically can be 100, 150, 200, 250, 300, 350 or 400 mm long, the length to width ratio can be in the range 1:1 to 50:1.

The use of AISI 430 stainless steel plate for the aperture plate 32 enables the holes to be punched readily through the plate. The holes are disposed in a regular array on the plate. Figures 9A to 9G show preferred forms of regular array. In Figure 9A the holes 57, 58 are located at

the corners of equilateral triangles with the bases and apexes of the triangles located parallel to one of the edges 40 of the aperture plate. In Figure 9B the holes 41 are located at the corners of hexagons again with the hexagons having one edge parallel to an edge 42 of the aperture plate. In Figure 9C the holes 43 are located at the corners of isosceles triangles with the base of the isosceles triangles being of less distance than the equilateral edges. The bases may alternatively be longer than the edges. The bases are arranged parallel with an edge 44 of the aperture plate. In Figure 9D the holes 45 are located at the corners of squares with an edge of the square parallel to an edge 46 of the aperture plate.

In Figure 9E the holes 47 are located at the corners of diamonds with a diagonal of the diamond parallel to an edge 48 of the aperture plate.

In Figure 9F the holes are arrayed in two alternating rows 49, 50 with the rows being at right angles to an edge 51 of the aperture plate. It is not necessary for the rows to lie at a perpendicular to the aperture plate, for example in Figure 9G holes 52 are arrayed in lines such as line 53 which is at an angle 54 to a perpendicular 55 to an edge 56 of the aperture plate.

Typically there may be 2775 holes per aperture plate with a centre to centre packing distance for the holes being in the range 0.7 mm to 1.5 mm, typically 1.2 mm. Thus in the case of the holes illustrated in Figure 9A each hole 57 would be at 1.2 mm from its nearest neighbour hole 58. Obviously, in the case of holes arrayed in different packing arrangements, the intercentre distance will differ from one hole to the other.

A cross section of a typical hole is shown in Figure 10. The hole is substantially trumpet shaped having a substantially parallel section 60 which has an internal

diameter 61 and a length 62. Above the parallel portion 60 there is a tapered portion 63. The length 62 of the narrow portion 60 is approximately equal to the diameter 61 of the narrow portion 60. The length of the hole is effectively, the length of the capillary or substantially parallel portion 60. The tapered portion 63 is effectively a means of delivering dope into the portion 60 of the hole. The portion 60 may have a diameter of 25 microns or 35 microns or 40 microns or 50 microns or 60 microns or 70 microns or 80 microns or 90 microns or 100 microns or 110 microns or 120 microns or 150 microns, depending on the eventual decitex of the fibre which is to be manufactured using the spinnerette. The length 62 may be equal to the diameter 61 or may be in the range 0.1 to 10 or 0.5 to 2 times the diameter 61.

The holes in the spinnerette can be made by any conventional manner, usually by drilling, punching and broaching. Typical manufacturing processes are described in the articles by Schwab and Langley in "Fiber Producer" referred to above.

In a spinnerette according to the invention, it is not essential that all of the holes have the same diameter in their capillary portion 60.

Referring to Figure 11 this shows a plan view of a spinnerette having an outer flange 70 and containing six aperture plates 71 to 76. The aperture plates are welded into a framework in the manner illustrated in Figures 3 to 8. On either side of the aperture plates 71 to 74 in the regions 71A, 71B to 74A, 74B the capillary portion of the holes is about 10 per cent larger in diameter than the capillary portion in the remaining parts of the plates 71 to 74. Similarly the capillary portions of the holes in the regions 75A, 75B and 76A, 76B are approximately 10 per cent larger in diameter than the holes in the remaining portions of the plates 75 and 76.

Rather than having the tapered portion 63 as a smooth taper, it may be easier to form the taper in a series of frusto-conical regions merging into the parallel portion 60.

The welded structure spinnerette according to the invention has a number of very significant advantages over the prior art structures.

The welded structure permits the use of thin aperture plates whilst still enabling a large area to be provided within which the aperture holes can be made. The thin aperture plates can be welded into a framework so as to withstand the distortion effects which arise with the use of high pressure dope. This advantage is of particular significance when using the spinnerette with high viscosity dope. The use of high viscosity dopes inevitably means that if high throughputs are required high pressures such as up to 200 bar must be used to force the dope through the aperture holes.

The welded structure also minimises dead areas within the spinnerette where the spinning solution can stagnate. These otherwise can give rise to non-uniform spinning, particularly in the case of spinning a hot dope into a cool region. The welded structure can readily be manufactured with a smooth underface.

A yet further advantage is that it enables rectangular designs readily to be produced. Because the plates can be preproduced prior to welding into the framework, the plates can have holes close to their edges. The plates can all be the same size, which means that the aperture plates can be manufactured on a repetition basis and if one plate contains defective holes than only a single plate needs to be rejected. Compared, therefore, to a large single plate spinning jet the product of the invention is much easier to manufacture and much less susceptible to distortion under pressure. If pressed, single jet plates are used of the type illustrated

in Figure 1A, it is very difficult to produce such a jet with holes close to the edges because of the difficulty of working inside a dished member. If only a single plate is used, it needs to be thick to avoid collapse which means that it is difficult to form holes through the plate and, therefore, it is not possible to pack the holes closely together.

The use of AISI 430 stainless steel, [containing 16-18% by weight chromium and low levels of nickel (less than 0.5%), manganese (less than 0.5% by weight) and molybdenum (less than 0.5% by weight) as well as low levels of carbon (less than 0.12 % by weight)] means that the plates may be punched and welded whilst still being able to resist the conditions of use.

CLAIMS

1. A spinnerette characterised in that it comprises a metal aperture plate (32), the plate (32) having a plurality of holes for the spinning of a shaped product from a spinning solution, the aperture plate (32) being welded around its periphery to a metal frame member (20, 22, 23, 24).

2. A spinnerette for the spinning of a plurality of cellulose filaments from a solution of cellulose in a solvent, the spinnerette having a frame member (20) defining a portion through holes which the solution is passed to form the filaments, characterised in that the holes closest to the frame member (20) are larger in diameter (61) at their smallest diameter portion (60) than the holes in a region more remote from the frame member (20).

3. A spinnerette according to Claim 2, characterised in that the portion through which the solution is passed to form the filaments comprises a metal aperture plate (32) having between 500 and 10,000 holes.

4. A spinnerette as claimed in Claim 1 or claim 3, characterised in that the frame member (20) has at its end opposed to the aperture plate (32) an outwardly extending integral flange (21).

5. A spinnerette as claimed in Claim 1, 3 or 4, characterised in that the aperture plate (32) is electron beam welded to the frame member (20, 22, 23, 24).

6. A spinnerette as claimed in any one of claims 1 and 2 to 5, characterised in that the frame member (20) has a rebate (31) into which the aperture plate member (32) is located and welded.

7. A spinnerette according to Claim 6, characterised in that there is a plurality of aperture plates (32) each of

a thickness in the range 0.5 to 3.0mm and corresponding substantially to the depth of the rebate (31).

8. A spinnerette as claimed in any one of Claims 1 and 3 to 7, characterised in that the aperture plate (32) is of stainless steel, preferably AISI 430 grade stainless steel.

9. A spinnerette as claimed in any one preceding claim, characterised in that the frame member is of stainless steel, preferably AISI 304 grade stainless steel.

10. A spinnerette as claimed in any one of Claims 1 and 3 to 9, characterised in that the frame member (20) is rectangular and the aperture plate (32) is welded into the frame member (20) so as to have the periphery of an inner side of the aperture plate (32) abutting the frame member (20) and in that the spinning holes (60) are tapered in internal diameter, and are larger on the inner side of the aperture plate (32).

11. A spinnerette as claimed in any one of Claims 1 and 3 to 9, characterised in that the diameter (61) of the holes in the central region of the aperture plate is smaller than the diameter of the holes adjacent at least one of the edges (71A, 71B, 72A, 72B, 73A, 73B, 74A, 74B, 75A, 75B, 76A, 76B) of the plate (71, 72, 73, 74, 75, 76).

12. A spinnerette as claimed in any one preceding claim, characterised in that there is provided at least one internal brace (22, 23, 24) in the interior of the metal frame (20) to provide at least two apertures (25) therethrough and in which the apertures (25) are rectangular.

13. A spinnerette as claimed in Claim 12, characterised in that the braces (22, 23, 24) are tapered at their upper edges and the tapers are so formed that the area of each aperture (25) at the entrance as defined by the tapered edges is equal.

14. A spinnerette as claimed in Claim 13, characterised in that the upper edge of the braces (22, 23, 24) lie in substantially the same plane as the upper face of a flange (21) of the frame member.

15. A spinnerette for the production of a plurality of cellulose filaments from a solution of cellulose in a solvent for the cellulose, characterised by:

i) a metal framework including an outer wall (20) of generally rectangular shape in plan view, the outer wall defining a space of depth between the two edges of the wall (20) equal to the depth of the spinnerette, the rectangular framework having a length and a width, wherein the length is greater than the width so as to define a major axis and a minor axis,

ii) an outwardly extending flange (21) around the periphery of the wall (20) integral with the wall,

iii) at least one major axis internal bracing wall (22, 23) and at least one minor axis internal bracing wall (24) transverse to the major axis bracing wall (22, 23) provided within the outer wall (20) thereby defining a plurality of apertures (25) through the framework,

iv) rebates (31) in the portions of the outer wall (20) and the portions of the braces (22, 23, 24) at the outer edges thereof around the periphery of each aperture (25) to accommodate in each aperture an aperture plate (32),

v) a plurality of metal aperture plates (32) dimensioned to fit into the rebates (31) around the apertures (25),

vi) a plurality of spinning holes formed in each of the aperture plates (32) through which the cellulose solution can pass to form the filaments, and

vii) the aperture plates (32) being welded in the rebates to the framework (20) and braces (22, 23, 24) around the entire periphery of each aperture plate (32).

16. A method of manufacturing a spinnerette for the production of a plurality of cellulose filaments from a solution of cellulose, characterised by:

i) providing a stainless steel framework including an outer wall (20) of a generally rectangular shape in plan view, the outer wall (20) defining a space of a depth between the two edges of the wall equal to the depth of the spinnerette, the rectangular framework having a length and a width, wherein said length is greater than said width so as to define a major axis and a minor axis,

ii) at one peripheral edge of the wall (20) providing an outwardly extending flange (21) around the periphery of the wall integral with the wall (20),

iii) providing within the outer wall (20) at least one major axis internal bracing wall (22, 23) and at least one minor axis internal bracing wall (24) transverse to the major axis bracing wall (22, 23) defining a plurality of apertures (25) through the framework,

iv) forming rebates (31) in the portions of the outer wall (20) and the portions of the braces (22, 23, 24) at the outer edges thereof around the periphery of each aperture (25) to accommodate in each aperture (25) an aperture plate (32)

v) forming each of the braces (22, 23, 24) with a tapered upper edge (27, 28, 29) remote from the rebated edge,

vi) forming a plurality of aperture plates (32) from stainless steel dimensioned to fit into the rebates (31) around the apertures (25),

vii) forming a plurality of spinning holes (60) in each of the aperture plates (25) through which the cellulose solution can pass to form the filaments, the holes being tapered so as to be larger in diameter on one side of said aperture plate (25) than on the other side,

viii) subsequent to the formation of the spinning holes in each of the aperture plates (32), locating the aperture plates (32) in the rebates (31) in the apertures (25) with the side of the aperture plate (32) having the larger diameter portion of the holes towards the bottom of the rebate (31), and

ix) electron beam welding the aperture plates (32) to the framework (20) and braces (22, 23, 24) around the entire periphery of each aperture plate (32).

17. A method as claimed in Claim 15 or 16, characterised in that the metal framework (20) and internal bracing walls (22, 23, 24) are machined from a solid plate.

18. A method as claimed in Claim 15, 16 or 17, characterised in that the smallest diameter of the holes is in the range 25μm to 200μm.

19. A method as claimed in any one of Claims 15 to 18, characterised in that the holes are spaced from one another by a centre-to-centre distance in the range 0.5mm to 3mm.

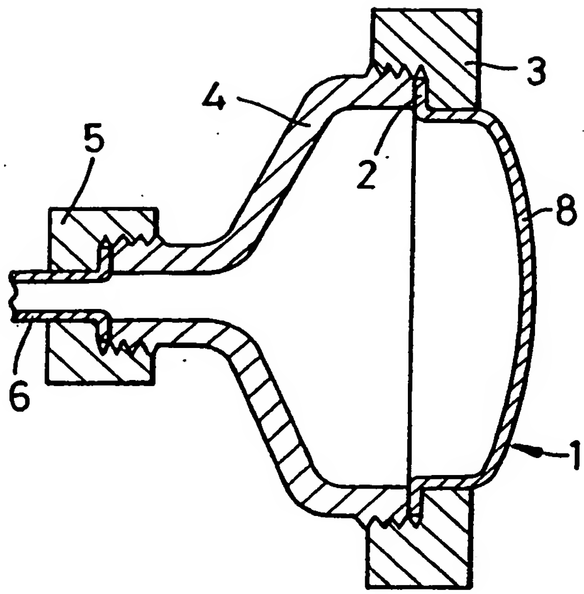

Fig. 1A

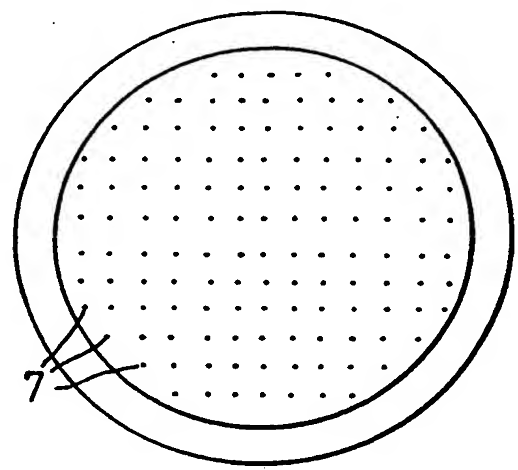

Fig. 1B

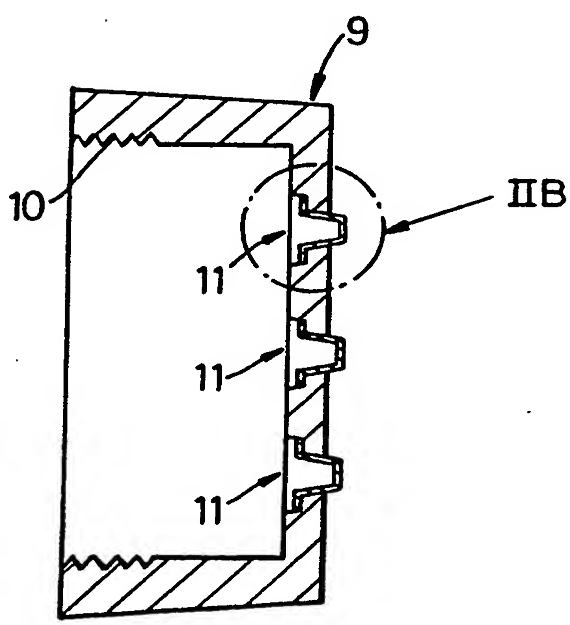

Fig. 2A

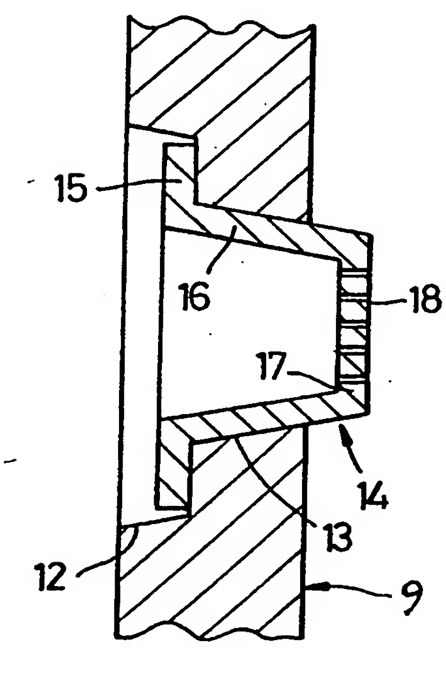

Fig. 2B

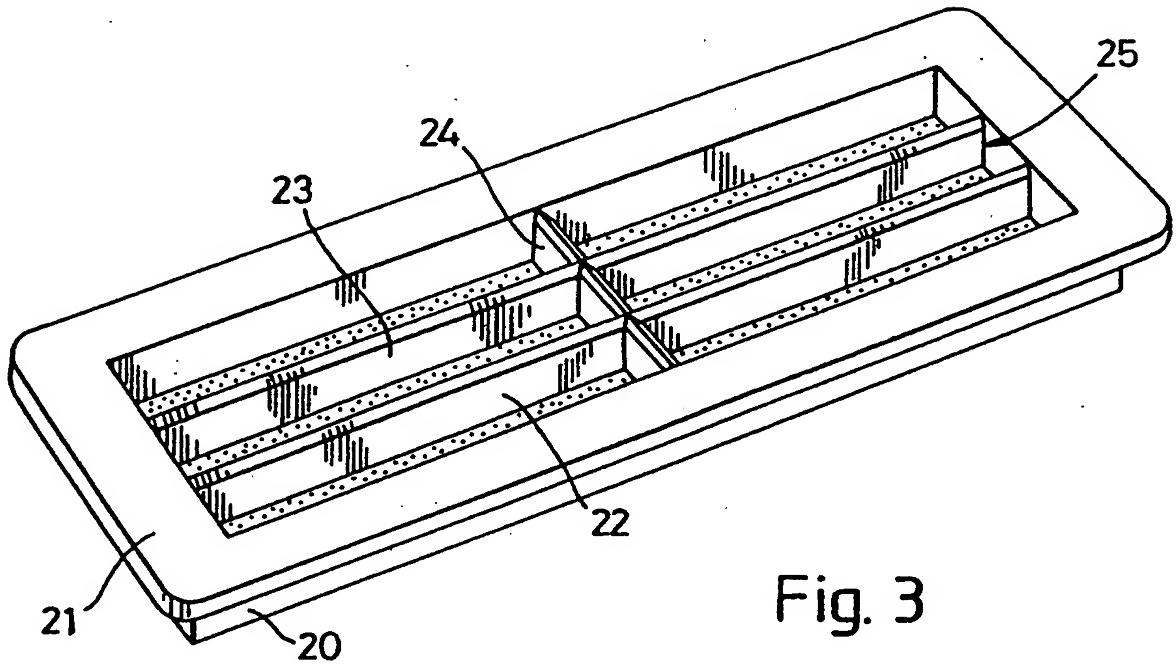

Fig. 3

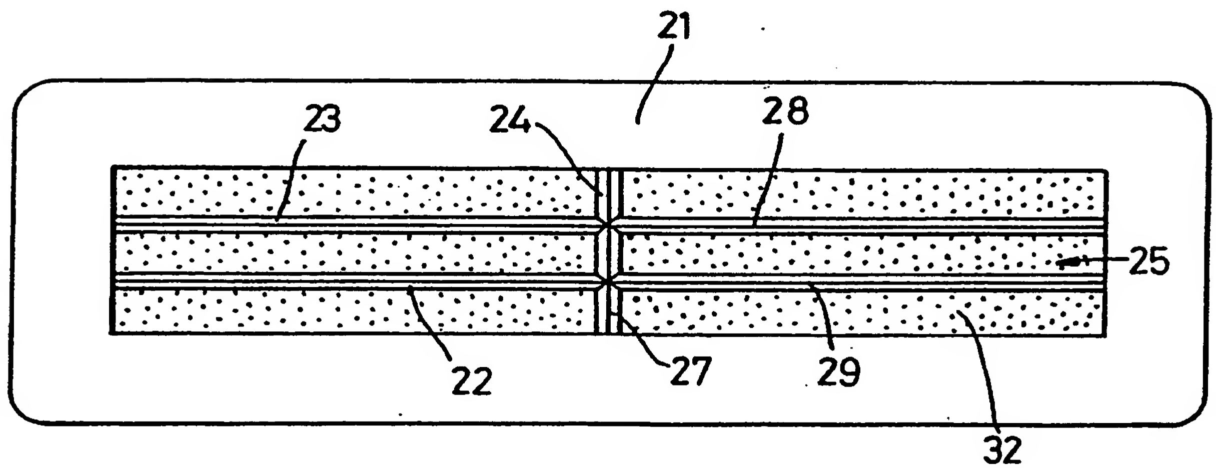

Fig. 4

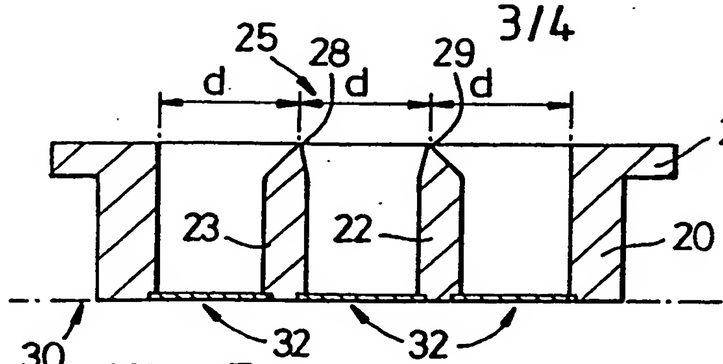

Fig. 5

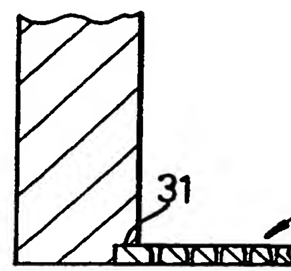

Fig. 6

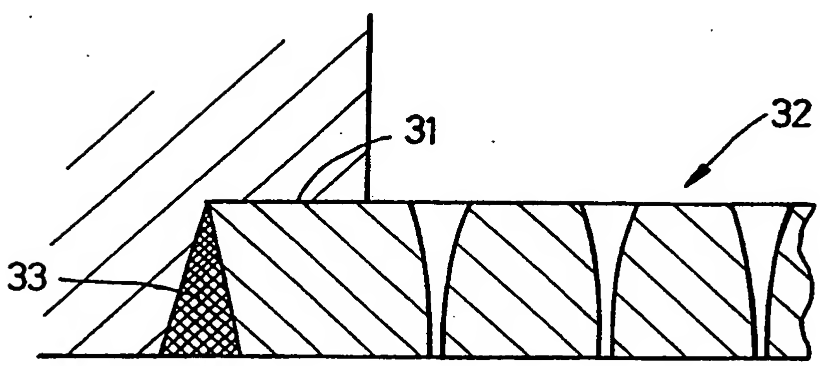

Fig. 7

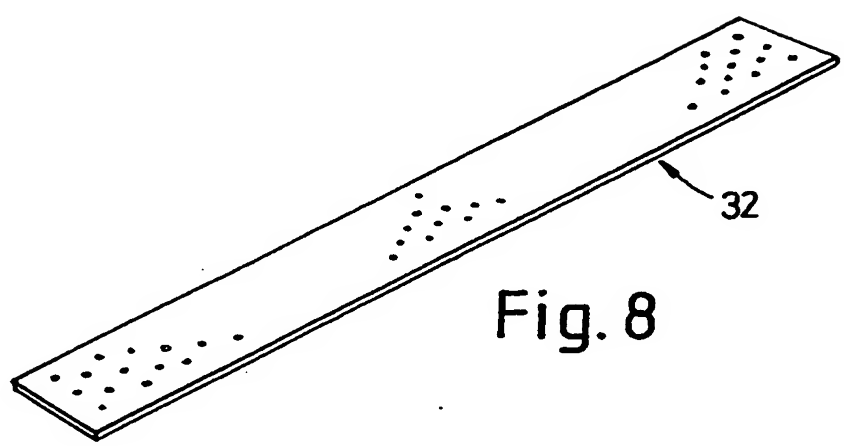

Fig. 8

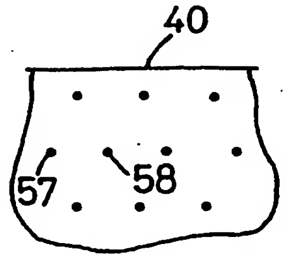

Fig.9A

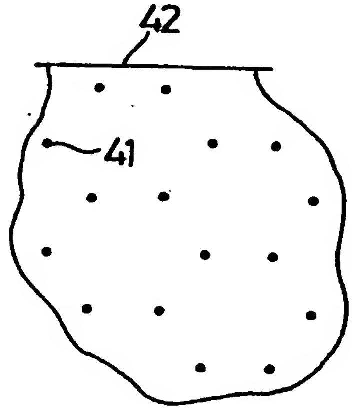

Fig. 9B

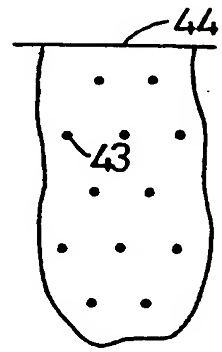

Fig. 9C

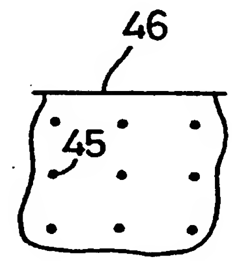

Fig. 9D

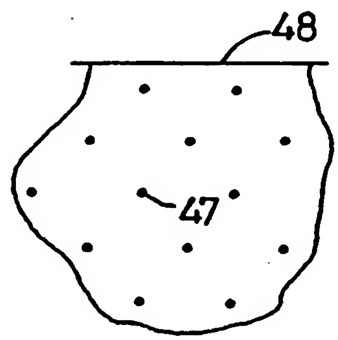

Fig. 9E

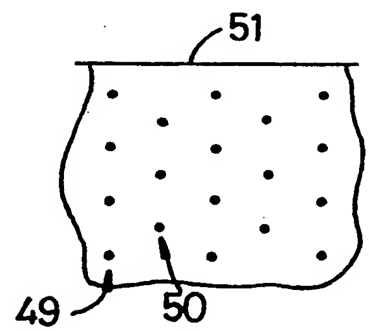

Fig. 9F

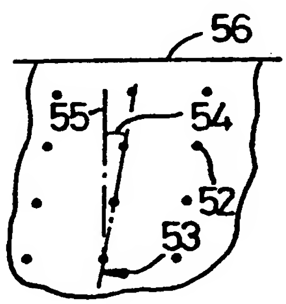

Fig. 9G

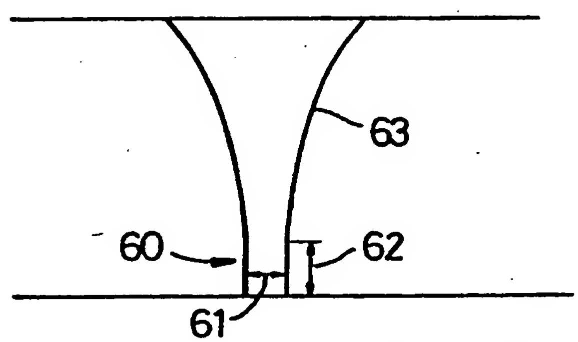

Fig. 10

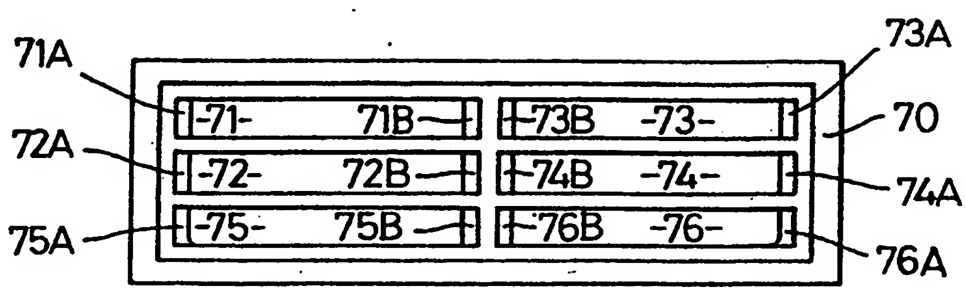

Fig. 11

INTERNATIONAL SEARCH REPORT

International Application No
PCT/GB 94/01100

A. CLASSIFICATION OF SUBJECT MATTER
IPC 5 D01D4/02 D01F2/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 5 D01D D01F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	DD,A,223 740 (VEB SPINNDÜSENFABRIK GRÖBZIG) 19 June 1985 see the whole document	1,4,5,8,9,12 6,7,10,15,18
Y	PATENT ABSTRACTS OF JAPAN vol. 12, no. 316 (C-524)26 August 1988 & JP,A,63 085 103 (TANAKA KIKINZOKU KOGYO KK) 15 April 1988 see abstract	6,7,15
Y	EP,A,0 494 852 (LENZING AKTIENGESELLSCHAFT) 15 July 1992 see the whole document	10,18

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents :

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"E" earlier document but published on or after the international filing date

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

1

Date of the actual completion of the international search	Date of mailing of the international search report
15 September 1994	29.09.94

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax (+31-70) 340-3016	Tarrida Torrell, J

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/GB 94/01100

Patent document cited in search report	Publication date	Patent family member(s)		Publication date
DD-A-223740		NONE		
EP-A-0494852	15-07-92	AT-B-	395863	25-03-93
		BG-A-	60111	15-10-93
		CA-A-	2059043	10-07-92
		JP-A-	4308220	30-10-92
		US-A-	5252284	12-10-93